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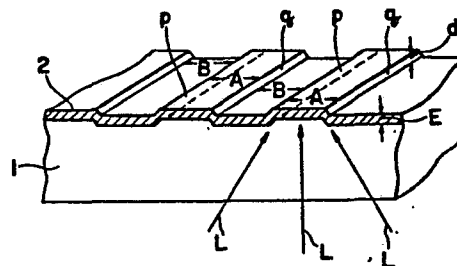
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54 Disc for optical record reproduction use.

57 An optical disc having recording film formed, which changes in beam reflectance or beam transmittance without accompanying geometrical deformation, due to the raised temperatures through the laser beam application, on a disc-shaped base (1) having geometrical rugged guide tracks (17) formed in advance.

Fig. 1 (b)



DISC FOR OPTICAL RECORD REPRODUCTION USE

The present invention relates to a disc for optical record reproduction use and more particularly, a disc for optical record reproduction use, wherein a beam modulated by the information signal such as image signal or the like is applied upon the recording medium to form a recording film, which changes in reflectance or transmittance, on the recording medium layer due to the temperature change caused through the beam application.

10. In recent years, in addition to an optical video disc for the exclusive use of reproduction, a disc for optical record reproduction use wherein the record reproduction can be performed immediately by the semiconductor laser, etc. is being developed. Most of the
15 developments are based on a system of drilling a hole in the recording film due to the laser heat to form the record bits, as disclosed within Japanese Patent Laid Open Publication No. 11430/1977. In addition, a group to which the present inventors belong to developed the other
20 recording films, for instance, a method of using sub-oxide film as a recording member, such as thin film composed of sub-oxide such as tellurium. This causes the film composed of the sub-oxide of the tellurium on the base

plate to absorb the laser beam to change the refractive index and the optical density due to the heat, and the quality of the reflection beam from the surface of the film substantially changes.

5 According to the drilling system of the former, the film is drilled through the evaporation or melting by the laser beam. Thus, larger laser power is required and the hollow disc construction for providing a shelter for evaporation material is required to be provided.

10 The thin film application of the latter has advantages in that the recording operation and the erasing operation can be performed with relative lower power. However, the latter has many problems yet to be settled. Cracks may be caused in the recording film due to decrease in the
15 recording power and the heat during the recording operation, or the rest unerased may be likely to be caused during the erasing operation. These problems of the above are required to be settled.

 Accordingly, an object of the present invention
20 is to provide a new disc which is free from the above-described problems, superior in terms of recording efficiency and recording bit positional accuracy.

 Another object of the present invention is to
 provide an optical disc having recording film formed,
25 which changes in beam reflectance or beam transmittance without accompanying geometrical deformation, due to the

raised temperatures through the laser beam application, on a disc-shaped base having geometrical rugged guide tracks formed in advance.

A further object of the present invention is to
5 provide an optical recording disc for focusingly applying laser beams on a recording member to record the information, in which concentrically or spirally convexed or concaved guide grooves are formed in advance on a disc-shaped resin base material of acryl or the like, a recording film
10 which changes in reflectance or transmittance through the application of the light is formed on the entire face of the guide grooves.

A still further object of the present invention is to provide an optical recording disc for focusingly
15 applying laser beams on a recording member to record the information, in which the guide grooves comprising geometrical rugged guide tracks are formed in advance on a disc-shaped resin base material of acryl or the like to form a recording film thereon, the film thickness of
20 the stage difference is properly set to considerably improve the recording sensitivity and to remove the cracking phenomena during the recording operation, and the relationship between the groove width and the laser beam diameter is properly set to render the recording
25 efficiency proper and to settle the rest unerased.

These and other objects and features of the present invention will become apparent from the following description taken in conjunction with the preferred embodiment thereof with reference to the accompanying
5 drawings, in which;

Figs. 1(a), (b) are partial sectional views for illustrating the construction of an optical record disc in accordance with the present invention,

Figs. 2(a), (b), Figs. 3(a), (b) and Fig. 4
10 are views showing the construction of some embodiments of a disc in accordance with the present invention, respectively, and

Fig. 5 is a view for illustrating the relation between the application beam and the guide track width in
15 a disc for an optical record reproduction use in accordance with the present invention.

Before proceeding the description of the present invention, it is to be noted that the like parts are designated like reference numerals throughout the
20 accompanying drawings.

Fig. 1(a) shows one example of a disc base material 1, which is provided with optical convex-shaped guide grooves B. Fig. 1(a) shows a partially enlarged disc base material, and the guide track A shown in
25 Fig. 1(a) is formed, in concentrical or spiral construction, almost uniformly on the entire face of at least

an area for recording signals. The width W of the track A is different depending upon the wavelength of a light source to be used or the coherency degree thereof. When semiconductor laser of approximately $8000\text{\AA}$ in wavelength is used as a light source, approximately 0.7 through $1\text{ }\mu\text{m}$ is preferable. Reference character T shows a track pitch of the track A which is prescribed by the content of a signal to be recorded and reproduced and the amount of the tolerable crosstalk of a signal between the tracks.

10 The track pitch T is set to a value of approximately 1.4 through $2.0\text{ }\mu\text{m}$. The height difference d between the guide track A and the groove B, which is located between the tracks, is set to the depth of $1/6$ through $1/12$ of the wavelength λ of the incident light so that asymmetrical

15 diffraction effect may be provided with respect to light, which is applied upon the guide track A. The disc base material 1, which is provided with such convex-shaped or concave-shaped guide grooves B can be made with an art of making the original panel of the conventional video

20 disc.

Fig. 1(b) shows a light sensitive recording material 2 (hereinafter referred to as light recording material) uniformly formed on the disc base material 1 shown in the Fig. 1(a). The light recording material 2

25 is formed to the thickness in the range of several hundreds $\text{\AA}$ through two thousands $\text{\AA}$ although the thickness is

different depending upon the types of the recording materials. Referring to Fig. 1(b), the recording light L which is incident from the side of the base material is closed to a light beam whose diameter is equal to 0.7
5 through $1.0\ \mu\text{m}$ (the width of the guide track A) or more. When the height d between the track A and the groove B on the disc is kept selected to the above-described $\lambda/6$ through $\lambda/12$ so that the end faces p, q of the guide track A may be caused asymmetrical diffraction effect in
10 the direction normal to the track A with respect to the axis of the incident light, the far field pattern of the reflection light on the light recording material face provides the better representation of the positional shift normal in direction to the track between the record
15 light and the track A so that the tracking error signals may be obtained. Accordingly, the track of Fig. 1(b) can be followed with a tracking mirror. As the base material 1, a material, which is optically homogeneous and transparent, such as polymethyl methacrylate resin,
20 polyvinyl chloride resin or the like can be used.

As a method of forming the guide grooves B, these resins can be used through the application of the conventional art of making the video disc as it was. Namely, grooves are formed by a hot press method or an
25 injection method or the like. The groove layer can be provided on the base material 1 using these resins with

the other resins such as ultraviolet hardening resin.

As the recording member 2, sub-oxide light absorbing film such as film composed of TeO_x ($x \approx 1$) can be applied.

The film can be formed, by a vacuum evaporation method, to
5 a given thickness independently of the ruggedness of the base material.

The effects to be produced from the construction and the construction for producing the effects to maximum will be described hereinafter in detail.

10 Fig. 2(a) shows the construction corresponding to that of Fig. 1(b). Referring to Fig. 2, a laser beam is applied upon the recording film 2a disposed on the relatively concave portion A, which constitutes the guide track of the base material 1. The recording film
15 2a absorbs the laser light to increase the temperature. The heat quantity caused at this time moves to the other portion of the base material and the recording film 2a to make escape. Stage difference is provided between a portion indicated with 2a and a portion indicated with
20 2b. Suppose the disc construction has a recording film formed on the plane base plate which is not provided with grooves therein, and the heat of the laser light escapes in all the directions along the recording film, with the result that the temperature increasing
25 efficiency of the laser beam application part is inferior, since the thermal conductivity of the recording film is

10 times or 100 times as compared with that of the resin base plate. Since the stage difference is caused in the film by this groove, the heat is correspondingly difficult to escape, with the result that the temperature is easily raised in the application position. Namely, the recording operation can be made with less laser power. According to the experiments of the inventors, cracks were caused in the film due to the raised temperature of the film during the recording operation in the case of the plane base plate free from grooves. However, no cracks were caused at all on such grooved disc of the embodiment of the present invention. The recording film, which is cut off in shape by the stage difference, has an effect of reducing the thermal distortion.

15 Then, the track width W , which most effectively raises the temperature by the laser beams, will be described hereinafter. The convex shape, which is constant in width and sufficiently long in length as a track A formed in concentric circle or spiral, will be described. The width W which is sufficiently greater as compared with the spot of the beam to be applied corresponds to a plane disc. Since the amount of film material per unit length becomes smaller as the width W becomes narrower, the thermal capacity reduces so that the temperature is likely to be raised. Also, since the contact area between the recording film and the base plate becomes smaller as

the information track width W becomes narrower, the thermal transfer amount to the base plate becomes smaller. The temperature rise is better when the guide track width W is as wide as the thickness w of the light beam or is somewhat smaller than it. Namely, in the conditions of ($w \geq W$), the effect is greater. The thickness w of the light beam means effective beam diameter which has sufficient strength to change the characteristics of a recording material within the beam application face during no-signals. The effect is the same even when the guide track A is shaped to become relatively concave as shown in Fig. 2(b). Particularly, when the thermal conductivity of the base material is sufficiently smaller than that of the recording film, no difference is provided between the convex shape shown in Fig. 2(a) and the concave shape shown in Fig. 2(b). When the width W of the track becomes narrower than the effective beam diameter w , difficulty is caused in terms of reproduction. Namely, the reflection light amount or transmission light amount caused by signals recorded on the track reduces, thus resulting in reduced S/N ratio. Generally speaking, the guide track A is optimum to be approximately the same as wide as or slightly narrower than the effective beam diameter. To achieve an expected object, the width of the guide track A is required to be in the range of $\pm 20\%$ of the effective beam diameter and is preferred to be in the range of $\pm 10\%$ of the effective beam.

The relationship between the thickness t of the recording film and the depth (height) d of the unevenness of the base material 1 will be described hereinafter.

When the relationship of $t \leq d$ is established as shown
5 in Fig. 3(a), the heat conduction within the recording film is cut off at the stage difference portion of the unevenness of the base material, and thus the above-described effect is greatest. Even when the relation of $t > d$ is established as shown in Fig. 3(b), the adiabatic effect
10 can be expected except when t is sufficiently larger than d . Particularly, in the case of $t \leq 2d$, the heat conduction of the recording film in the stage difference becomes half or less of the heat conduction of the plane so that with the result that the effect is large.
15 Namely, the recording film is preferred to be at least two times as thick as the stage difference of the groove.

In one embodiment of the new disc construction described hereinabove, PMMA of 1 mm in thickness was used as a grooved base material. The stage difference
20 was $700 \text{ \AA}$, the width of the concave portion was $8000 \text{ \AA}$, the evaporated recording film was TeOx ($x \approx 1$) and $1400 \text{ \AA}$ in thickness. When the recording operation was performed with semiconductor laser, which was closed to a spot of approximately $8000 \text{ \AA}$ by an optical system of $\text{NA} = 0.5$, the
25 recording operation could be effected with the laser power of approximately three fifth in the case of the

grooved base material as compared with the non-grooved base material.

Then, an example where a protective layer adhered on the recording film has been coated as the construction of the practical disc will be described hereinafter. Fig. 4 shows an embodiment wherein the recording film 2 is covered with the other member 3 for the purpose of the mechanical protection. Even in this case, geometrical convexes or concaves are provided on the base material 1 as shown in the drawing, when the thermal conductivity of the protective member 3 is sufficiently small, to improve the recording sensitivity. An optically homogeneous resin such as polystyrene having thermal conductivity $0.8 \text{ through } 1.2 \times 10^{-3} \text{ J/cm sec.}^\circ\text{k}$ is dissolved in the solvent of aromatic or the like such as xylene and is coated, dried thereby to provide the material 3. In the case of such adhesion protective construction, deformation and evaporation are required to be avoided as a method of making records on the film with laser beams. Only a method of varying the optical condition, such as reflection factor, without change in the shape can be used. Generally, the recording film is extremely thin as approximately $1000\text{\AA}$. Since the film is heated during the recording operation, it is likely to be oxidized in a condition where it is exposed to air. Once it is oxidized, the transmission factor becomes layer in that

portion. Transparency is distributed in accordance with the distribution of the temperature near the recording bit. Namely, blur is caused in the recording bit. This fact causes S/N to decrease in the case of the FM type recording. However, such adherent protective layer is formed to prevent the oxidization.

Since the low oxide film of tellurium described hereinabove has an erasing property in certain composition conditions, as disclosed within the Japanese Patent Publication No. 3725/1979. The member is whitened at a portion where the slightly strong beam of the semiconductor laser is applied and is blackened at a portion where the beam weaker than it is applied. Also, the whitening and blackening conditions can be provided through variation of the laser pulse width. Namely, the member is whitened through the short time application of the beam of 100 nsec. or less and is blackened through the long time application of the beam of 200 nsec or more. This whitening operation and blackening operation can be repeatedly performed.

Fig. 5 is a view for illustrating an embodiment of the record erasure in such erasing disc as described hereinabove. Referring to Fig. 5, a base material is generally at 1. A film for erasure recording use is generally designated at 2. A laser beam is generally designated at D_1 in a case where the writing-in operation has been effected with the laser of the beam

diameter narrower than the width of the convex-shaped guide track. The laser beam for erasure use narrower than the guide track width is generally represented at D_2 . Also, reference character g is a white bit signal written in. Reference character h is one portion of the white bit signal not erased. When the laser beam diameter is narrower than the track width, the rest unerased is caused due to some shifting of the laser beam running operation. Referring to Fig. 5, D_1' , D_2' , g' correspond to the above-described D_1 , D_2 and g. An example is shown where the diameter of the laser beam is almost the same as the width of the guide track or is slightly thicker than it. In this case, the rest unerased is not caused, since the laser beam runs along the track. The conditions of ($W \leq \omega$) of such beam diameter ω and the groove width W as described hereinabove is provided from such erasing conditions as described hereinabove.

Accordingly, the disc construction of the present invention can provide advantages in such a manner that the groove is formed and the film thickness of the stage difference is properly set to considerably improve the recording sensitivity and to remove the cracking phenomena during the recording operation. In addition, the relationship between the groove width and the laser beam diameter is properly set to render the recording efficiency proper and to settle the rest unerased.

Although the present invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by
5 the terms of the appended claims.

What is claimed is:

- 1 1. An optical recording disc for focusingly
2 applying laser beams on a recording member to record
3 the information, characterized in that recording film
4 is formed, which changes in beam reflectance and/or
5 beam transmittance due to the temperatures through
6 the laser beam application, on a disc-shaped base
7 having geometrical rugged guide tracks formed in
8 advance, the width of the guide track being approximately
9 the same as the diameter of the effective spot of said
10 laser beam..
1 2. An optical recording disc in accordance with
2 Claim 1, wherein said disc-shaped base is made of a
3 transparent body and a protective layer which is inferior
4 in thermal conductivity to said recording film.
1 3. An optical recording disc in accordance with
2 Claim 1, wherein said recording film layer is two times
3 or less as thick as the rugged stage difference of said
4 guide track.
1 4. An optical recording disc in accordance with
2 Claim 1, wherein the width of said guide track is in
3 the range of +20% of the effective spot diameter of
4 said laser beam.
1 5. An optical recording disc in accordance with
2 Claim 1, wherein said guide track comprises concentrically
3 or spirally convexed or concaved guide grooves formed on
4 a disc-shaped resin base material.

Fig. 1 (a)

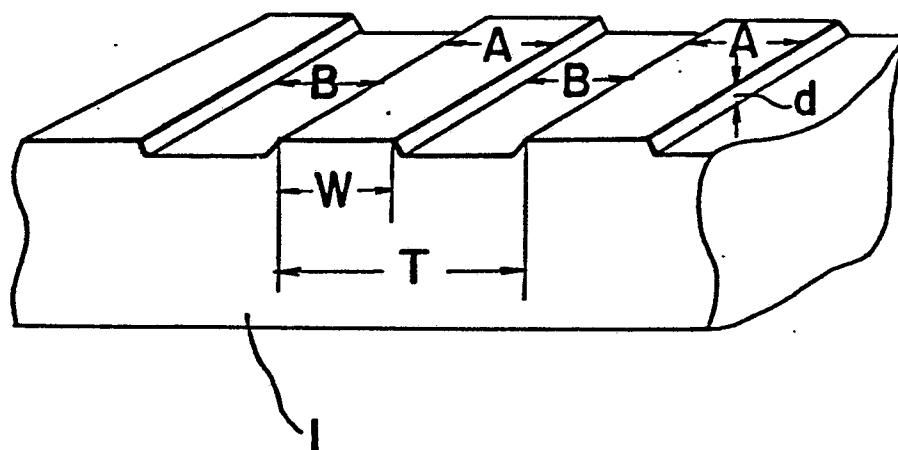


Fig. 1 (b)

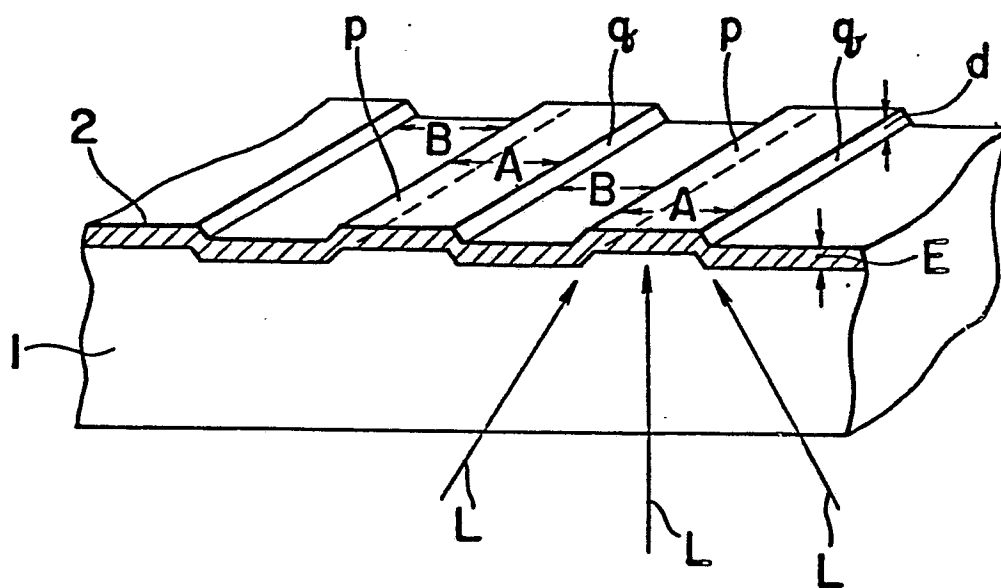


Fig. 2(a)

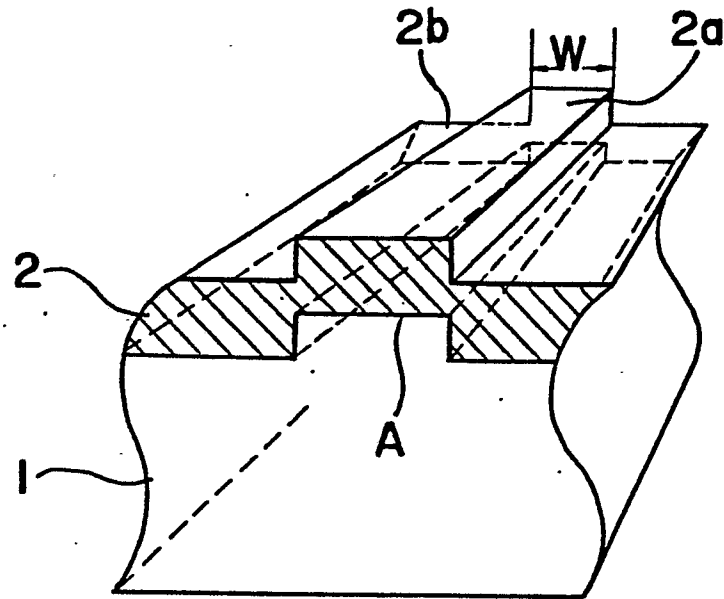


Fig. 2(b)

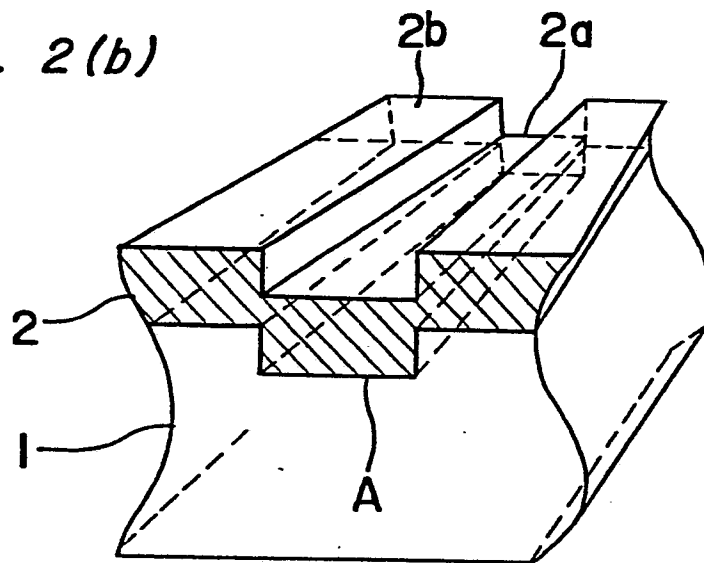


Fig. 3(a)

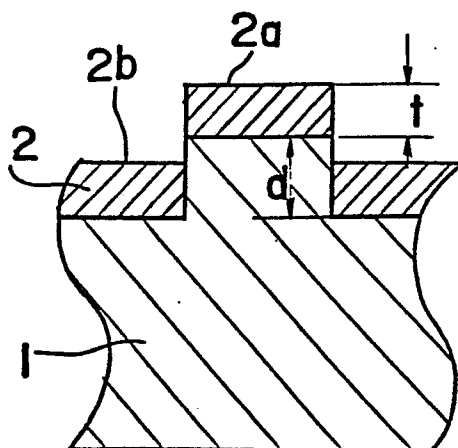


Fig. 3(b)

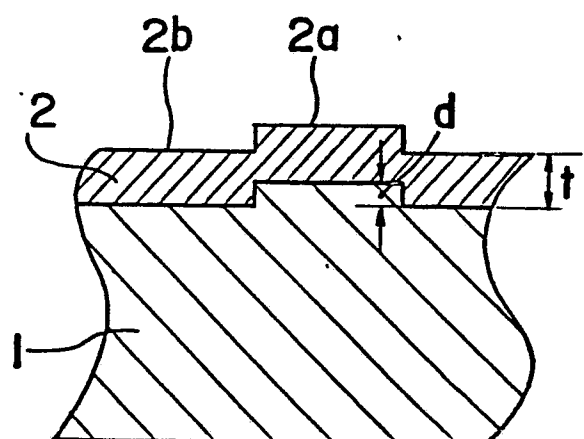
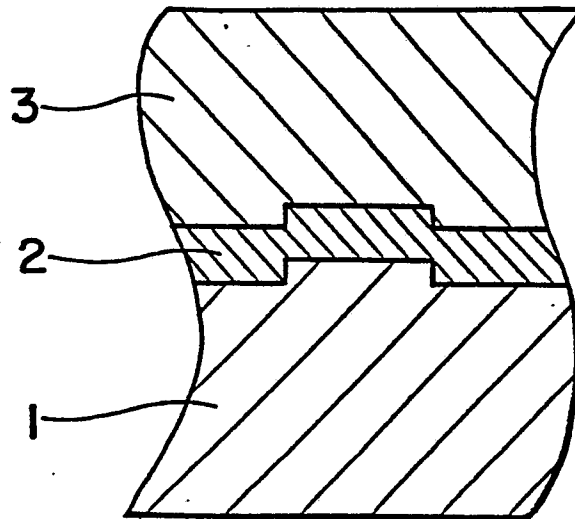
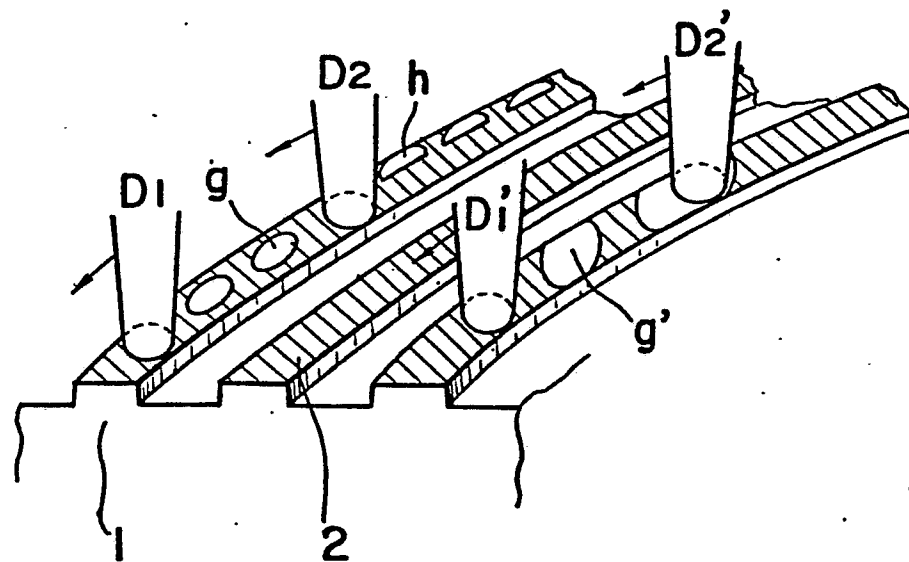


Fig. 4*Fig. 5*



DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	Patents Abstracts of Japan Vol. 1, No. 73, 14 July 1977 page 845E77 & JP - A - 52 - 10102 --	1	G 11 B 7/24 B 41 M 5/24
A	FR - A1 - 2 321 164 (THOMSON-CSF) claims 1, 2, 3; fig. 1 * --		
A	LASER + ELEKTRO-OPTIK, Vol.11, No. 1, 1979, Stuttgart "Optischer Speicher mit Diodenlaser zeichnet 10¹⁰ Bit auf einer 30-Zentimeter-Platte auf" pages 14 to 17 * page 15, right-hand column * ----		TECHNICAL FIELDS SEARCHED (Int. Cl.³) B 41 M 5/00 G 11 B 7/00
			CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
X The present search report has been drawn up for all claims			&: member of the same patent family, corresponding document
Place of search		Date of completion of the search	Examiner
Berlin		30-06-1981	LEITHÄUSER